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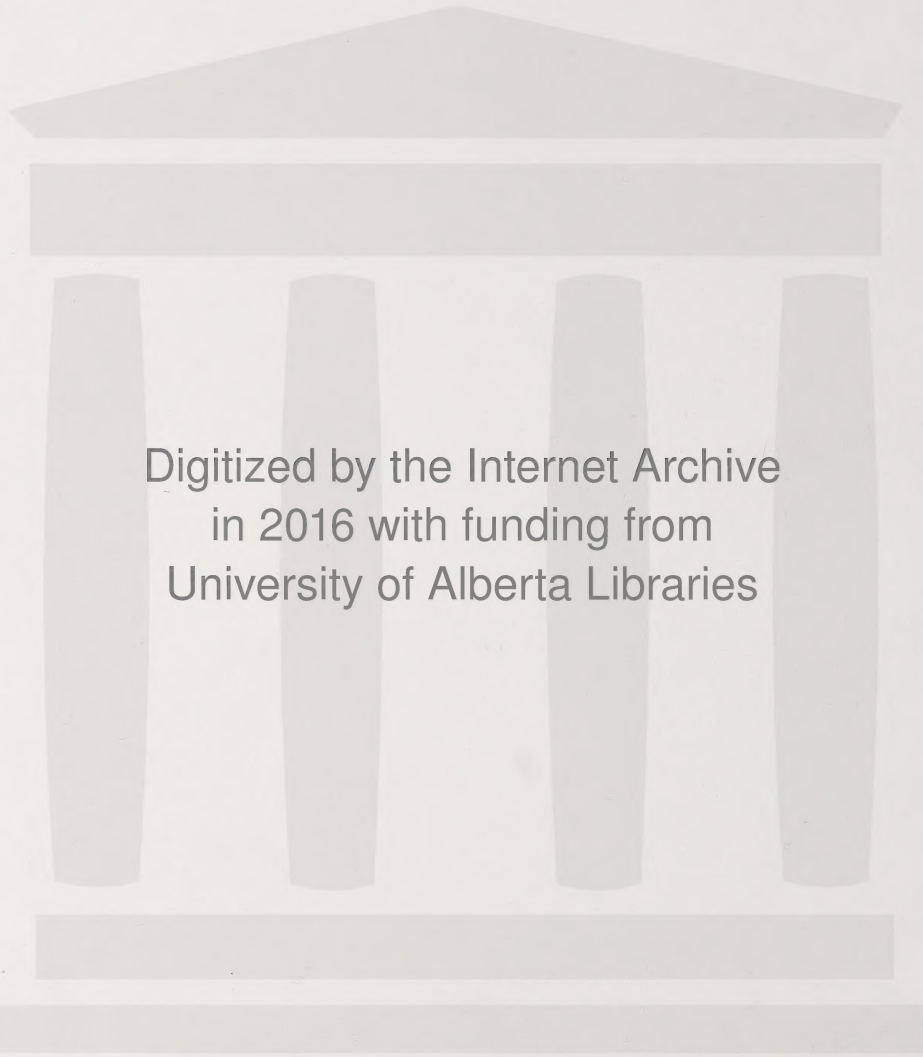
Mathematics 10

SAMPLING



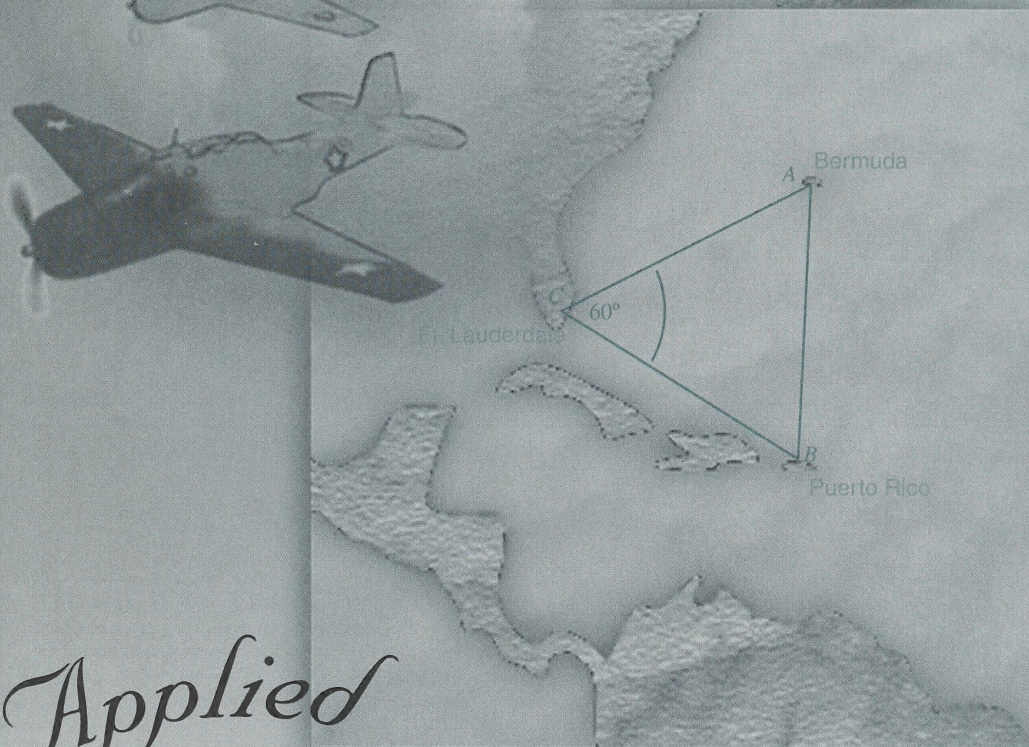
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Module 4



Applied

Mathematics 10

SAMPLING

Applied Mathematics 10
Student Module Booklet
Module 4
Sampling
Learning Technologies Branch
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This document is intended for	
Students	✓
Teachers	✓
Administrators	
Parents	
General Public	
Other	



The Learning Technologies Branch has an Internet site that you may find useful.
The address is as follows:

<http://www.learning.gov.ab.ca/ltb>

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

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Welcome

Applied Mathematics 10

Module 1
Measurement

Module 2
Number Patterns in Tables

Module 3
Relations and Functions

Module 4
Sampling

Module 5
Line Segments

Module 6
Linear Functions

Module 7
Trigonometry

*Welcome
to Module 4.
We hope you'll
enjoy your study
of Sampling.*



Applied Mathematics 10 contains seven modules and a final test. Work through the modules in the order given, since several concepts build on each other as you progress through the course.

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*Submit the
Module Project.*



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*Submit the
Module Assignment.*

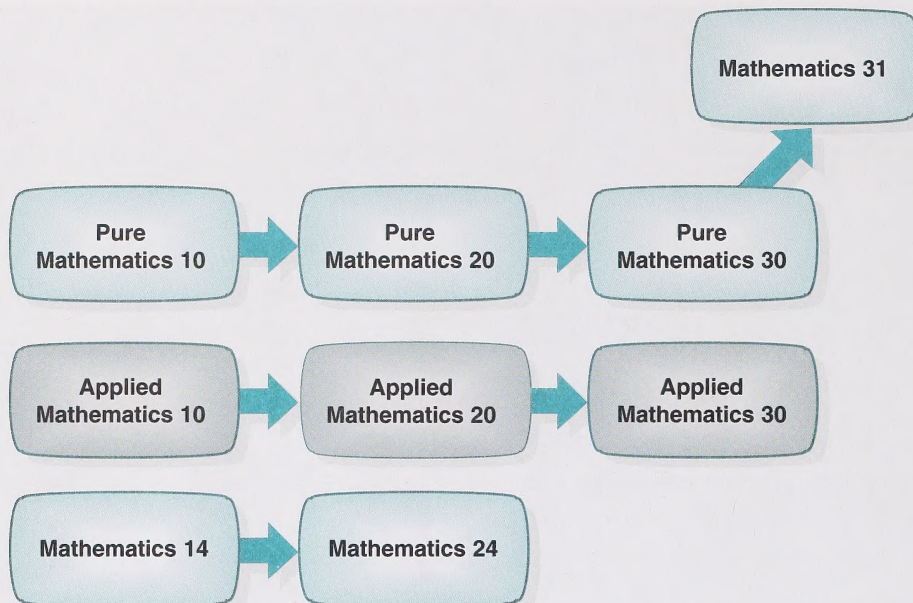


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Introduction to Applied Mathematics 10

Applied Mathematics 10 is the first course in the Applied Mathematics 10–20–30 program of studies. Another program of studies is Pure Mathematics 10–20–30; students who complete Pure Mathematics 30 often choose to take Mathematics 31. A third program of studies is Mathematics 14–24.



Each mathematics program is designed for students with different mathematical strengths and interests.

- Pure Mathematics 10–20–30 is intended for students who are strong in algebra and mathematical theory.
- Applied Mathematics 10–20–30 is better suited to students who prefer to solve problems using numerical reasoning or geometry.
- Mathematics 14–24 is a general mathematics program for high school students who have experienced difficulties in previous mathematics courses.

Each sequence of courses is designed for students with different post-secondary and career plans.

You may find it helpful to read mathematics updates on Alberta Learning's website:

<http://www.learning.gov.ab.ca/studentprograms>

Before enrolling in Applied Mathematics 10, it is recommended that you talk with a school counsellor about your career plans.



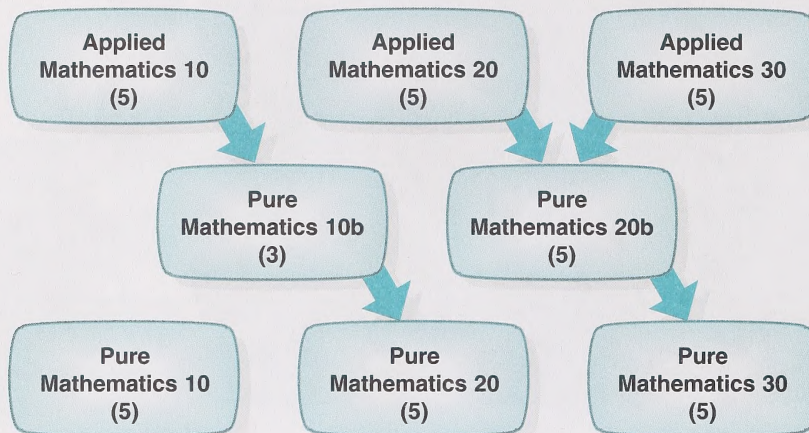
TRANSFERRING FROM THE APPLIED MATHEMATICS PROGRAM

You should be aware that the applied and pure mathematics courses do have some topics in common; other topics are specific to either the applied or pure mathematics courses.

The following table shows some of the common topics and some of the independent topics in the mathematics program.

Applied Topics	Common Topics	Pure Topics
• linear programming • data tables and trends • design and layout • metric and imperial measure • data presentation • vectors and matrices • periodic, fractal, and recursive patterns • financial decision making • costing and design problems	• spreadsheets • line segments and linear graphs • scaling • triangles • surveys • financial mathematics • quadratic functions • circle geometry • the bell curve	• irrational numbers • exponents • polynomial and rational expressions • mathematical expectation • growth patterns • linear and non-linear systems • operations on functions • mathematical reasoning • exponential and logarithmic functions • conics • combinations • trigonometric functions

If you want to transfer from the Applied Mathematics 10–20–30 sequence to the Pure Mathematics 10–20–30 sequence at a future time, you won't have to repeat the topics that are common to pure mathematics and applied mathematics. If you decide to transfer to Pure Mathematics 20 after successfully completing Applied Mathematics 10, you may take the 3-credit course called Pure Mathematics 10b. If you decide to transfer to Pure Mathematics 30 after successfully completing Applied Mathematics 20 or Applied Mathematics 30, you may take the 5-credit course called Pure Mathematics 20b. The two bridging courses are shown in the following diagram.



STRATEGIES FOR COMPLETING APPLIED MATHEMATICS 10

For each module in Applied Mathematics 10, there is a Student Module Booklet, a Project Booklet, and an Assignment Booklet. The document you are presently reading is called a Student Module Booklet.

Each Student Module Booklet will show you, step by step, what to do and how to do it. There are readings, questions for you to answer in your mathematics binder, and applications that will give you hands-on experience.

It is important to work systematically and carefully through the Student Module Booklets. This work will prepare you for the projects, assignments, and final test.

Following are some suggestions for organizing your mathematics binder:

- Keep a section of your binder to record your responses to the questions in the Student Module Booklet. Also, store your marked assignments here.
- Keep a section of your binder for work in progress on your projects. Keep your research notes, plans, rough drafts, and so on.
- Keep a section of your binder to record new skills and concepts as well as important results and formulas. Get in the habit of describing new skills and concepts in your own words, and recording useful ways to help you remember what a concept means. Make charts and diagrams to help you connect mathematical ideas.
- Keep a section of your binder to record mathematical accomplishments. This can include solutions to problems that you are proud of solving. It can also include landmark events, such as when you grasped a difficult concept (an “aha!” experience) or when you used a calculator or spreadsheet in a new way.

Mathematical Processes

Throughout this course, you will be expected to perform the following mathematical processes:

- Connect mathematical ideas to everyday experiences and to concepts in other disciplines.
- Develop and use problem-solving strategies.
- Reason and justify your answers.
- Communicate mathematical ideas.
- Select and use appropriate technologies to solve problems.
- Develop and use estimation and mental-math strategies.
- Use visualization to assist in processing information, making connections, and solving problems.

In order to develop these mathematical processes more fully, you are encouraged to ask someone who is also taking Applied Mathematics 10 to be your study partner. You will find that having a friend with whom you can discuss mathematical ideas will make your studying more enjoyable.



Resources You Will Need

In addition to the distance learning materials for Applied Mathematics 10, you will need the following resources:

- the *Addison-Wesley Applied Mathematics 10 Source Book*, Western Canadian Edition, published by Addison Wesley Longman Ltd. (1999)
- a binder, lined loose-leaf paper, graph paper, dividers, a pencil, and an eraser
- metric and imperial measuring devices, such as a ruler, a tape measure, a yardstick, a vernier caliper, and a micrometer
- a mathematical instrument set (compass, protractor, and triangles)
- a computer installed with a spreadsheet program

Note: Two popular spreadsheet programs are *ClarisWorks™* and *Microsoft® Excel*. The examples in this course show *Microsoft® Excel*.

- a graphing calculator

Note: Where it is applicable, the examples in this course and the textbook show the TI-83 calculator; however, all of the graphing calculators in the following chart are approved for use on tests.

Brands	Casio Instruments	Sharp	Casio
Models	TI-82 TI-83 TI-83 Plus TI-86 TI-89 TI-92 TI-92 Plus	EL-9600c EL-9600* EL-9300* EL-9200*	CFX-9850Ga-Plus CFX-9850G* CFX-9800G* FX-9700 series*

*no longer commercially available, but may be available on loan from your school division

If you intend to use the TI-83 or TI-83 Plus graphing calculator, it is recommended that you view the video *The TI-83 Graphing Calculator Video Tutor* to discover some of the calculator's features.

Many of the resources you will need for this course may be purchased from the Learning Resources Distributing Centre (LRDC). Following is the LRDC website:

<http://www.lrdc.edc.gov.ab.ca>

You may wish to discuss the availability of resources with your teacher, as your school division may have a loan policy.

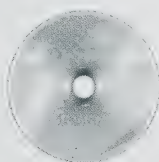
Visual Cues

You will find many visual cues in this course. Colour is used to highlight terms that are defined in the Glossary of the Appendix of each Student Module Booklet. You will also find several icons in the margins. Read the explanations given to discover what the various icons prompt you to do.

- Refer to the textbook.



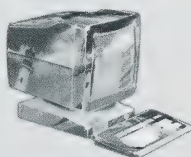
- Use the companion CD for Applied Mathematics 10.



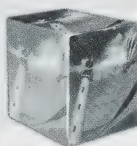
- Use mathematical instruments, measuring devices, and other materials.



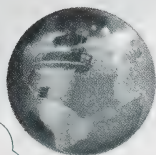
- Work with a computer.



- Complete the module project or assignment.

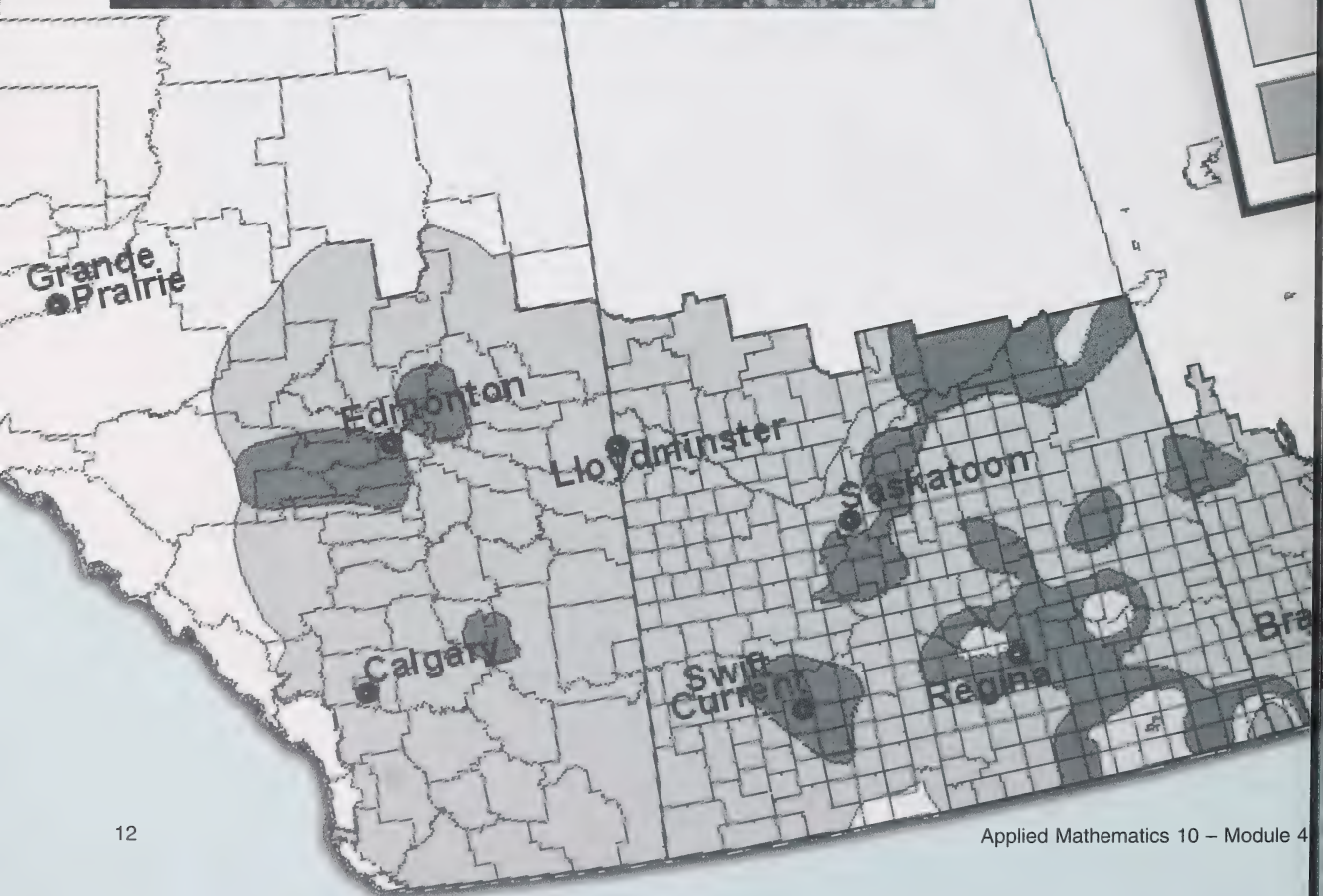


- Explore the Internet.



Remember: Any Internet website address given in this module is subject to change.

MODULE OVERVIEW





A farmer near Swift Current, Saskatchewan, checks the Department of Agriculture Internet site and finds that cumulative moth counts for Bertha armyworm are high in the area in which his farm is located. He now checks his canola crop for Bertha armyworm larvae. He measures out an area 1 m by 1 m and shakes the canola plants vigorously. He then counts the number of Bertha armyworm larvae in the 1-m² area and records the number in his record book. He then repeats this process in two additional areas of the canola field. If the farmer finds 20 or more larvae per square metre in each area he checks, he will have to consider applying a pesticide to his crop to save it from extensive damage.

This farmer is using a statistical sampling method to determine whether pest control is required to save the canola crop on his farm. How representative of the entire field are the samples he takes? Is his sampling technique statistically sound? Are his results reliable and valid?

In this module you will investigate sampling techniques in statistics. You will identify the need to sample and recognize commonly used biased sampling techniques. You will find out how to recognize statistically sound sampling techniques and whether a sampling method is reliable and valid. You will analyse survey design and then apply what you have learned to design and conduct a survey to test the feasibility of a proposed business venture.

EVALUATION

Accompanying this Student Module Booklet is a Project Booklet and an Assignment Booklet. Your grading in this module will be based upon the module project and the module assignment you submit for evaluation. The mark distribution is as follows:

Module Project	40 marks
Module Assignment	<u>60 marks</u>
TOTAL	100 marks

Remember that Activities 1 to 5 in this Student Module Booklet will prepare you for completing the module project and the module assignment. Work through these activities carefully and compare your answers with the suggested answers in the Appendix.

The Follow-up Activities provide extra help and enrichment. You may choose to do some or all the questions in the Follow-up Activities. Again, you should compare your answers with the suggested answers provided in the Appendix.

¹ Agriculture and Agri-Food Canada, *Bertha Armyworm in Western Canada in 1998*. Reproduced with the permission of the Ministry of Public Works and Government Services Canada, 2000.



Beginning the Project

Trish and Angela decided to open a small business, Toddler Time. They based many of their business decisions—the type of business, hours of operation, the goods and services they would offer, and pricing—on surveys they conducted. Do you have a dream of being your own boss and running your own business? Do you think your dream of owning a small business is feasible?

Your project for Module 4: Sampling is called Feasibility of a Small Business. This project involves choosing a possible business to operate and determining the feasibility of the venture by conducting a survey.

For your module project, you will need to determine your potential customers' interest in the products and/or services, hours of operation, and price structure. You will develop a questionnaire to gather this information from your potential customers, choose the population for which your business will operate, select a reliable method of sampling, conduct a survey of the selected sample using the questionnaire, and analyse the results.



Turn to page 164 of the textbook and read “Look Before You Leap!” Then complete the questions posed. Store your answers in the project section of your mathematics binder.

After you have recorded some of your initial ideas for planning a new business, begin researching some of the things you may need to know.

You may wish to begin your research by visiting Addison-Wesley Longman Ltd.’s Internet site, described on page 165 of the textbook. Here you can read about some of the things others have done when starting a new business. Be sure to keep notes about your findings in your notebook.

Working through Activities 1 to 5 will help you gain the skills and concepts that you will need to complete the module project and module assignment. As you work through the activities, continue to research sampling techniques, bias, reliability of survey results, and ways of designing surveys. Continue to examine various surveys around you—restaurants and small shops often have customer satisfaction cards. Many sites on the Internet encourage you to participate in surveys. Perhaps you or your family had the opportunity to participate in telephone surveys. Talk to friends and/or family members to discover what they think about various surveys.

You will be given more direction on how to complete the project later in this module. In the meantime, continue exploring the topic and keep notes, samples, and ideas in the project section of your mathematics binder. Feel free to discuss your project with your study partner. Just remember that the work on the project you submit must be your own.





ACTIVITY 1

Why Sample?

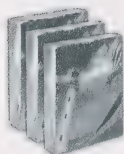
Recently, the City of Toronto conducted a survey to find the number of times city residents rode a bicycle in the previous seven days. In their survey, the City asked cyclists to list the starting and ending destination as well as the streets along which they cycled for each trip. In addition, respondents were asked to state whether they cycled to work, to school, to the shopping mall, for recreation, and so on. Respondents were also asked to indicate how often they cycle and what time of year they cycle.

The purpose of the survey was “to understand cycling patterns in Metro Toronto so as to develop a five-year bicycle network plan.”

The respondents to this survey were a representative **sample** of the cyclist **population** in Metro Toronto.

1. Why was a sample used to determine the pattern of cyclists in Metro Toronto?

Compare your response with the suggested answer in the Appendix, Activity 1, page 44.



For more information on reasons for **sampling**, turn to page 166 of the textbook and read the introductory information, “Why Sample?”

2. Define the following terms.

- a. sample
- b. population
- c. sampling

Compare your responses with the suggested answers in the Appendix, Activity 1, page 44.

Work through the following examples to review how samples can be used to make predictions about the entire population.

Example

The student council at Northwood High School had to make a decision about what colour the school jackets should be. They had a choice of four colours—blue, green, gold, and garnet. Before making a decision, the student council wanted to predict what percent of the school population would prefer each colour choice.



Solution

Following are the steps the student council used to solve the problem.

Step 1: The student council decided on the survey question:

What colour of school jacket do you prefer—blue, green, gold, or garnet?

Step 2: The student council randomly selected 20 of the 180 students to interview. They asked each of these students the survey question. The council recorded the responses in a frequency table like this.

Colour	Tally	Frequency
Blue		2
Green		5
Gold		6
Garnet		7

Step 3: The student council used proportional reasoning to calculate the percent of students who prefer each colour.

Blue

$$\frac{2}{20} = \frac{10}{100}$$

$$= 10\%$$

Green

$$\frac{5}{20} = \frac{25}{100}$$

$$= 25\%$$

Gold

$$\frac{6}{20} = \frac{30}{100}$$

$$= 30\%$$

Garnet

$$\frac{7}{20} = \frac{35}{100}$$

$$= 35\%$$

Example

Stephen wanted to estimate the number of dandelions, broad-leaf plantains, and clover plants in his lawn.



Solution

Here are the steps Stephen used to solve this problem.

Step 1: To make the counting easier, Stephen used string and posts to divide the lawn into 200 equally sized squares.

Step 2: Stephen randomly selected a sample of 20 squares. He then identified and counted the weeds in this sample. He recorded the data in a frequency table like this.

Kind of Weed	Tally	Frequency
Dandelions		15
Broad-leaf Plantains	I	6
Clover Plants	II	12

Step 3: Stephen used proportional reasoning to estimate the total number of each kind of weed in the entire lawn.

Dandelions

$$\frac{15}{20} = \frac{x}{200}$$

$$x = 150$$

Broad-leaf Plantains

$$\frac{6}{20} = \frac{x}{200}$$

$$x = 60$$

Clover Plants

$$\frac{12}{20} = \frac{x}{200}$$

$$x = 120$$

Stephen estimates that there are 150 dandelions, 60 broad-leaf plantains, and 120 clover plants on his lawn.



3. Turn to pages 166 and 167 of the textbook and answer exercises 1 to 5 of “Investigation 1: Being One and Only.”

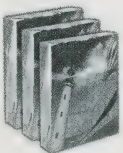
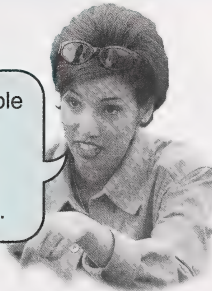
Note: In place of a class, you may wish to consider people you know in your city, town, or rural neighbourhood. In place of a school, you may wish to consider all the people in your city, town, or rural neighbourhood.

4. Turn to page 167 of the textbook and answer exercises 1 to 4 of “Investigation 2: Home, but Not Alone.” **Note:** Again, in place of a class, you may wish to consider the people you know in your city, town, or rural neighbourhood.

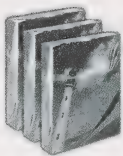


Compare your responses with the suggested answers in the Appendix, Activity 1, page 45.

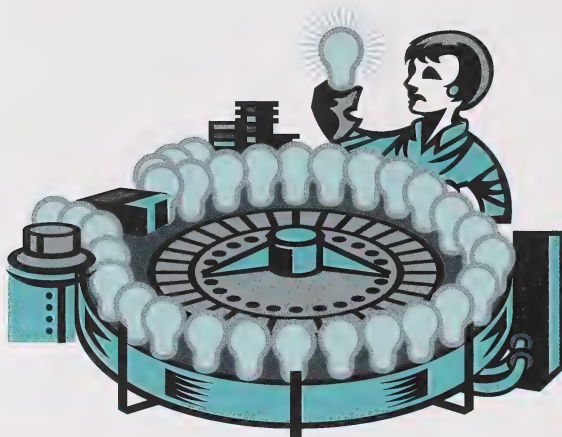
The population used for a sample varies as the question for the survey varies. A particular question may determine the population used in the survey.



Turn to pages 167 and 168 of your textbook and work through “Example: Identify a Possible Population.” As you read the possible populations provided in the solution, remember a population is defined as those who could have been consulted.



5. Turn to pages 168 and 169 of the textbook and answer exercises 1, 2, 3, 5, and 6 of “Exercises: Checking Your Skills.”
6. Turn to page 170 of the textbook and answer exercise 7 of “Exercises: Extending Your Thinking.”



Compare your responses with the suggested answers in the Appendix, Activity 1, pages 46–47.

When an entire population is surveyed, the process is called a **census**.

Governments, wildlife groups, and other interested parties conduct and/or sponsor annual population censuses of endangered species. One example of such a census is the Saskatchewan-based Operation Burrowing Owl (OBO), which compiles an annual population count or census of burrowing owls in Saskatchewan.



Use the Internet to research Operation Burrowing Owl. You will find the following website helpful:

<http://www.unibase.com/~nature/obo.htm>

You could also visit the Alberta Environment site or the Canadian Wildlife Service to find more information on the census or count of various endangered species:

- <http://www.gov.ab.ca/env/>
- <http://www.cws-scf.ec.gc.ca/>

Statistics Canada conducts a census every five years. This enumeration provides a statistical portrait of Canada and its people—a snapshot of the social and economic conditions of the country. The department also conducts on-going surveys in many other areas.

For example, in March 1999, household surveys were done on Canadian travel, the labour force, and youth in transition; business surveys were done on for-hire trucking, passenger bus transportation, and the performing arts; other surveys were done on vehicles, farm finances, and the hog industry.

Use the Internet to research how Statistics Canada conducts a census and survey. You will find the Statistics Canada website helpful:

<http://www.statcan.ca/>

7. Turn to page 168 of the textbook and answer exercises 1 and 2 of “Discussing the Ideas.”

Compare your responses with the suggested answers in the Appendix, Activity 1, page 47.



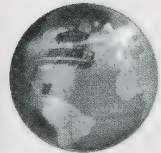
LOOKING BACK

In this activity, you discovered what is meant by a population, a sample, and a census.



8. Turn to page 170 of the textbook and answer “Communicating the Ideas.”

Compare your response with the suggested answer in the Appendix, Activity 1, page 47.



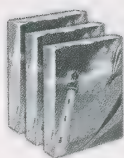


ACTIVITY 2

Reliability, Validity, and Bias of a Sample

Many large cities have problems involving commuter traffic.

A Greater Vancouver Regional District survey taken in 1992 showed that the average commuter in that area spent a total of 48 minutes per day driving to and from work. The survey also showed that 66% of commuters drove alone, 25% used car pools, and 9% used public transportation. Would the results of the survey have been the same if only teenage workers in the area were surveyed? If only workers living on acreages were surveyed?

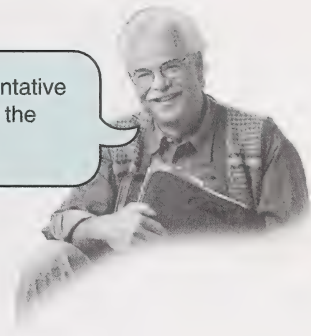


Turn to page 171 of the textbook and read the introductory paragraph of “Reliability, Validity, and Bias.”

1. Write a definition for each of the following:
 - a. sample statistic
 - b. reliability
 - c. bias

Compare your responses with the suggested answers in the Appendix, Activity 2, page 48.

For more insight into how representative a sample is of a population, do the following investigation.



2. a. Choose a new CD, movie, or book that you like. Ask five friends their opinion of the item chosen and record the number who like this particular CD, movie, or book.

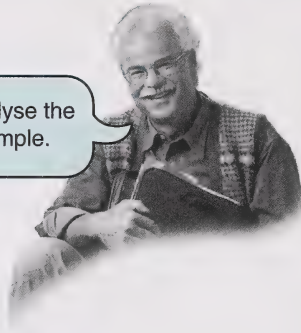


- b. Based on your friends' responses, predict what the population of your school or town might say about the CD, movie, or book.
- c. Ask the same question of five family members or relatives. Describe any differences in their responses compared to what your friends thought of the CD, movie, or book.
- d. Do you think the ages of your family members or relatives affected whether they liked the CD, movie, or book?
- e. Based on the responses of your family members or relatives, predict whether or not the general population would like this particular CD, movie, or book. Would your friends or family be a more representative group of the general population?

- f. Would you say the sample of your friends is a biased or non-biased sample for the general population liking a CD, movie, or book that you like?

Compare your responses with the suggested answers in the Appendix, Activity 2, page 48.

Now you will analyse the validity of a sample.



Turn to page 172 of the textbook and read the information regarding validity (the first paragraph of “Investigation 2: Validity”).

3. Define *validity*.
4. Turn to page 172 of the textbook and answer exercises 1 to 6 of “Investigation 2: Validity.”

Compare your responses with the suggested answers in the Appendix, Activity 2, pages 48–50.

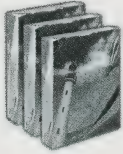
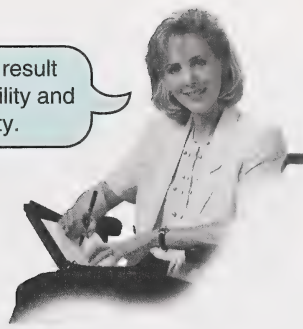


How would you determine whether a particular survey result is valid? Read the example on page 173 of the textbook and answer the following questions.

5. Which Calgary residents do you think responded to the phone-in-survey? Do you think this type of survey is valid?
6. What other reason does the example on page 173 suggest as to why the survey result may not be valid?

Compare your responses with the suggested answers in the Appendix, Activity 2, page 50.

Bias in a survey result leads to low reliability and lack of validity.



7. Turn to page 174 of the textbook and answer exercises 1 to 7 of “Exercises: Checking Your Skills.”
8. Turn to page 175 of the textbook and answer exercise 9 of “Exercises: Extending Your Thinking.”

Compare your responses with the suggested answers in the Appendix, Activity 2, page 51.

LOOKING BACK

In this activity, you explored bias and how bias affects the reliability and validity of survey results. You discovered how to recognize whether a survey result is reliable and valid.



9. Turn to page 175 of the textbook and answer “Communicating the Ideas.”

Compare your response with the suggested answer in the Appendix, Activity 2, page 52.

ACTIVITY 3



Biased Sampling Techniques

An Edmonton company is hired to find out which Canadian football team fans feel would win the Grey Cup at the end of the football season. To gather the data, the company considers polling 500 people. These people would be chosen by visiting five football games in Edmonton and surveying the first 100 people who come to each game.

1. Do you think the survey in the given example is biased? Explain.

Compare your response with the suggested answer in the Appendix, Activity 3, page 52.

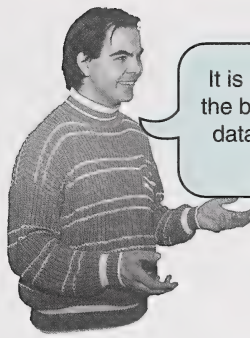
Individuals, groups, and companies gather data in various ways. They normally take great care to ensure that their samples are valid and reliable. However, sometimes biased sampling techniques are used.

There are a number of methods of gathering data—some methods provide valid and reliable surveys; some have biased sampling methods. Turn to page 176 of the textbook and read Tutorial 4.3, “The Gathering of Data.”

2. List and describe two biased sampling methods.

Compare your responses with the suggested answers in the Appendix, Activity 3, page 52.





It is important to be familiar with some of the biased sampling methods in gathering data and to be able to recognize biased sampling in a given situation.



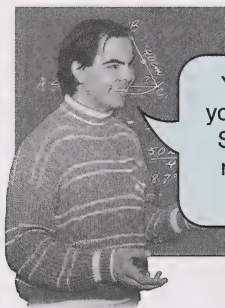
Turn to pages 176 to 178 of the textbook. Study Examples 1, 2, and 3 “Identify the sampling method.”

3. What major characteristic identifies a convenience sample?
4. What major characteristic identifies a self-selected sample?
5. Convenience sampling and self-selected sampling are examples of **non-probability sampling**. Explain how a person offering perfume samples is an example of non-probability sampling.



6. Turn to page 178 of the textbook and answer exercise 1 of “Discussing the Ideas.”

Compare your responses with the suggested answers in the Appendix, Activity 3, page 52.



You will now have a chance to practise your skills in recognizing bias in sampling. See how good you are at assessing the reliability or validity of various sampling techniques.

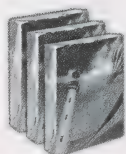


7. Turn to pages 178 and 179 of the textbook and answer exercises 1 to 6 of “Exercises: Checking Your Skills.”
8. Turn to page 179 of the textbook and answer exercise 7 of “Exercises: Extending Your Thinking.”

Compare your responses with the suggested answers in the Appendix, Activity 3, page 53.

LOOKING BACK

In this activity, you explored two biased, yet common, sampling methods: convenience sampling and self-selected sampling.



9. Turn to page 179 of the textbook and answer “Communicating the Ideas.”

Compare your response with the suggested answer in the Appendix, Activity 3, page 54.



ACTIVITY 4

Unbiased Sampling Techniques

Do you live in an urban or rural area? How many telephones are in your household? If there were an election today, for which party would you vote? Have you or a member of your family participated in a survey recently?

In the previous activity you reviewed some sampling methods that were biased. In this activity you will analyse sampling methods that minimize the amount of bias involved.

One way good sampling techniques minimize bias is through using random numbers in selecting individuals.

PRODUCING RANDOM NUMBERS

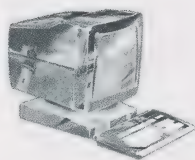


Before you analyse different sampling techniques, you will look at a number of different ways of producing random numbers.



Turn to pages 180 and 181 in the textbook and read through “Sampling Techniques” (read to the middle of page 181). Next, do the following:

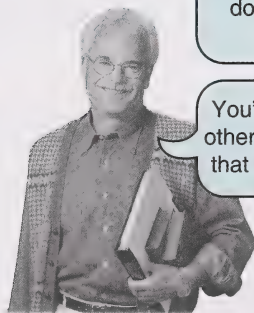
- Use the given instructions in exercise 1 on page 180 in the textbook to create a spinner. Next, use the spinner to generate 25 random numbers.
- Follow the given directions in exercise 2 on page 180 of the textbook to generate 25 random numbers using a telephone book. Are there any patterns in the 25 numbers you generated?
- Turn to pages 407 and 408 in the textbook and work through Utility 11. This utility gives instructions for generating random numbers on the TI-83 calculator. Next, use your graphing calculator to generate 25 random numbers. **Note:** If you are using a different calculator, follow the instructions in your calculator manual.
- Use the given instructions in exercise 4 on pages 180 and 181 of the textbook to create a random number generator using a computer spreadsheet. Use the spreadsheet to generate 25 random numbers.



1. Explain how you can use a telephone directory to randomly generate two-digit numbers.
2. Turn to page 183 of the textbook and answer exercises 1 and 2 of “Discussing the Ideas.”

Compare your responses with the suggested answers in the Appendix, Activity 4, page 54.

SAMPLING METHODS



All sampling techniques don't use simple random numbers, do they?

You're right! There are other sampling methods that provide valid data.





Turn to pages 181 and 182 in the textbook and read the information on four statistically sound sampling methods: simple random sampling, systematic sampling, cluster sampling, stratified random sampling.

3. In your own words, describe each of the four statistically sound sampling methods.

Compare your response with the suggested answer in the Appendix, Activity 4, page 54.

You need to be able to recognize the different sampling methods.



Read the following examples.

Example

Shanda's school has 350 students. She does a survey in her school by letting each student's name be represented by a number between 1 and 350 and then using the random number generator on her calculator to select 35 numbers.

- a. Which sampling method is Shanda using?
- b. Why was this method selected?

Solution

- a. Shanda is using the simple random sampling method.
- b. Generating random numbers on a calculator avoids bias and makes the sample results more valid and reliable.

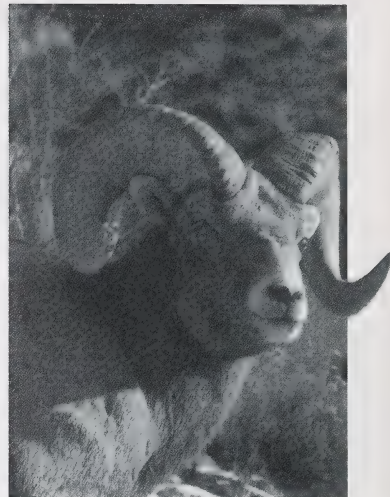


Example

The park rangers in one of Canada's national parks want to survey the mountain sheep population to determine the age, sex, and general health of the animals.

The rangers select at random one of the herds of mountain sheep in the park and examine each member of that herd.

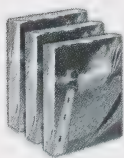
- a. Which sampling method is being used by the park rangers?
- b. Why was this sampling method chosen?



Solution

- a. The rangers are using the cluster sampling method.
- b. This method was probably chosen because the mountain sheep naturally congregate in herds. It saves time and money to examine animals that are in the same area.

Also, because the sample herd was randomly chosen, it is representative of the mountain sheep population in the park.



Turn to page 183 of the textbook and read "Identify the Sampling Method" to see more sampling examples.

4. Turn to page 183 of the textbook and answer exercises 3 and 4 of "Discussing the Ideas."
5. Turn to pages 184 and 185 of the textbook and answer exercises 1, 2, 3, and 7 from "Exercises: Checking Your Skills."
6. Turn to page 185 of the textbook and answer exercise 8 of "Exercises: Extending Your Thinking."

Compare your responses with the suggested answers in the Appendix, Activity 4, page 55.

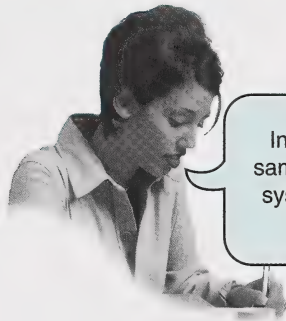
At the beginning of Activity 3, you read about the ACNielsen Company (now the Nielsen Media Research company), a “leader in market research and analysis.”



Use the Internet to research how the Nielsen Media Research company collects data on the TV viewing habits of Canadians. Go to the following website, click on Welcome, and then click on “Methodology”:

<http://www.nielsenmedia.ca>

LOOKING BACK



In this activity you explored four unbiased sampling methods: simple random sampling, systematic sampling, cluster sampling, and stratified random sampling.



7. Turn to page 185 of the textbook and answer “Communicating the Ideas.”



Compare your response with the suggested answer in the Appendix, Activity 4, page 55.



ACTIVITY 5

Survey Design

“Hey! That shirt is major cool!”

Have you and your friends ever gone window-shopping? Have you expressed an opinion on various display items? Is an informal survey such as this valid? Is it biased? Is it reliable?

Turn to page 187 of the textbook and read the six key components that have to be considered in designing a valid and reliable survey.

Then work through the example on page 188 of the textbook.

1. Turn to page 188 of the textbook and answer exercises 1 and 2 of “Discussing the Ideas.”
2. Turn to page 189 of the textbook and answer the following:
 - a. exercise 1 **or** exercise 2 of “Exercises: Checking Your Skills”
 - b. exercise 3 of “Exercises: Extending Your Thinking”

Compare your responses with the suggested answers in the Appendix, Activity 5, pages 56–57.



You should examine media reports on surveys critically. When details about the survey design are not given, or when biased sampling methods are used, you should be skeptical about the conclusions.



Turn to pages 186 and 187 of the textbook and read the three articles.

3. a. Which report gives the least information about the survey design?
b. Which survey appears to be most informal?
4. What is meant by the statement, “The poll is accurate within plus or minus 1.6 percentage points 19 times out of 20.”

Compare your responses with the suggested answers in the Appendix, Activity 5, page 58.

Questionnaires for surveys must be carefully designed. Following are suggestions for writing survey questions.

- You may choose to use **closed-ended questions**. Closed-ended questions restrict the response to particular answers you have selected. Look at the following example of a closed-ended question.

Please mark a check mark (✓) by the items you look for when you need sporting goods.

☐	wide selection
☐	good quality of goods
☐	low prices
☐	trained, knowledgeable salespeople
☐	inexpensive second-hand equipment
☐	rental equipment
☐	other (please specify)

- You may choose to use **open-ended questions**. Open-ended questions let the consumer express his or her own opinion and provide a variety of responses. An example of this type of question is as follows.

Where did you make your latest sports equipment purchase and why?

Open-ended questions are difficult to evaluate and many only produce a general category response. Responses may indicate that saving money is the primary consumer concern; you may have wanted to learn about the quality of products or the kind of staff needed.

- You may wish to use **scales** that allow the respondent to rate items from most important to least important with a numerical response. Look at the following example.

Please rank, in order of importance, the things you look for when you need sporting goods.

Assign 1 to the most important, 2 to the next, and 6 to the least important.

_____ wide selection

_____ quality of goods

_____ low prices

_____ trained sales staff

_____ second-hand equipment

_____ rental equipment



A **Likert Scale** could also be used. (You can find out more about this type of scale on the Internet. Use *Likert Scale* as your search term.) The respondent will determine if he or she disagrees or agrees with statements you have made. An example follows.

I always purchase the least expensive sports equipment.

Strongly
Disagree

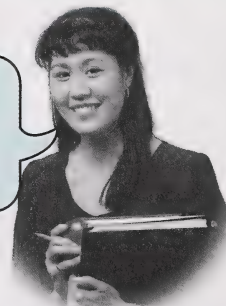
Disagree

Neither Agree
or Disagree

Agree

Strongly
Agree

The information you require and the ease of tabulating responses will determine which method you will choose to select. Who you choose to survey may also influence the type of questioning you use.



5. Maxine's Restaurant conducts a client survey by placing a copy of the following questionnaire at each table.

CLIENT SURVEY

At Maxine's, we welcome your comments. Please fill out this questionnaire and place it in the comments box.

How would you rate these aspects of Maxine's?

	Excellent	Good	Poor
• employee courtesy	☐	☐	☐
• speed of service	☐	☐	☐
• food quality	☐	☐	☐
• cleanliness	☐	☐	☐

What type of questions does this survey use?

Compare your response with the suggested answer in the Appendix, Activity 5, page 58.

LOOKING BACK



In this activity you analysed survey design. You identified a number of key components of a reliable survey. You used your knowledge to design a reliable survey.



6. Turn to page 189 of the textbook and answer "Communicating the Ideas."

Compare your response with the suggested answer in the Appendix, Activity 5, page 58.

Follow-up Activities

In this module you explored various aspects of sampling, designing a survey, and conducting a survey. You should now be able to identify bias in a sample, recognize unsound sampling methods and statistically sound sampling methods, and understand how to design a survey.



Review the skills and concepts that were developed in this module by reading the summary, “What Do I Need to Know?” on page 192 of the textbook. Also, read the important results and formulas that you discovered.

1. Turn to page 193 of the textbook and answer exercise 1 of Part A of “What Should I Be Able to Do?”
2. Turn to page 194 of the textbook and answer exercises 2, 3, 4, and 6 of Part B of “What Should I Be Able to Do?”

Compare your responses with the suggested answers in the Appendix, Follow-up Activities, pages 58–61.

If you had difficulties understanding the skills and concepts in Module 4: Sampling, it is recommended that you do the Extra Help. If you have a clear understanding of the skills and concepts in this module, it is recommended that you do the Enrichment. You may decide to do both.

EXTRA HELP

In this module, you analysed sampling techniques and found out how to recognize methods that result in both biased and unbiased samples of a population.

You discovered that sampling techniques where individuals are selected on the basis of a common element are biased. This type of sampling is called convenience sampling.

You also discovered that sampling methods that involve individuals deciding to respond to a question or questionnaire results in a biased sample. This type of sampling is called self-selected sampling.

1. Identify the sampling method in each of the following examples:
 - a. A company asks its employees to respond to a new policy through email.
 - b. A school checks into the need for additional parking space for student cars by having a student ask the opinions of drivers as they leave the parking lot.

- c. You try to determine the number of students who would be interested in having a particular band for the school dance by asking your friends.
2. Why is a phone-in response to a television talk show not a reliable survey method?

Compare your responses with the suggested answers in the Appendix, Follow-up Activities: Extra Help, page 61.

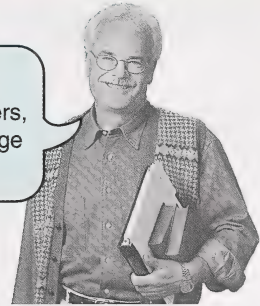
You also identified four reliable sampling techniques: simple random sample, systematic sample, cluster sample, and stratified random sample.

3. Briefly describe how a random number selection is made in each of the four statistically sound sampling methods. Give an example of where each of these sampling methods is used.

Compare your response with the suggested answer in the Appendix, Follow-up Activities: Extra Help, page 61.

ENRICHMENT

Surveys are an important way of gathering information for businesses, program developers, and governments. The Internet contains a large number of surveys from various sources.



1. Use various search engines to search the Internet for surveys. Analyse each survey for the six key components of a well-designed survey. Enter search terms such as *surveys* or *polls*. **Note:** You may find the following site useful.

<http://www.angusreid.com/>

2. Turn to page 194 of the textbook and answer exercise 5 of Part B of “What Should I Be Able to Do?”

Compare your responses with the suggested answers in the Appendix, Follow-up Activities: Enrichment, page 61.



MODULE PROJECT

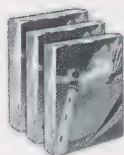
FEASIBILITY OF A SMALL BUSINESS



Completing the Project

By now you should have completed your initial research for the Module 4 project, Feasibility of a Small Business. You should have decided the kind of business for which you will gather information and compiled various notes and ideas.

To complete the Feasibility of a Small Business project, you will be asked to design, conduct, and analyse a survey for a business. You may wish to use the business you chose for Module 2 or you may choose a new business.



Turn to page 190 of the textbook and read, “Gathering Reliable Information.” For your project, you will conduct a survey to determine if there is enough interest in your business to make it successful.

Complete the activities in the first three bullets on page 190.

Keep a copy of your work in the project section of your mathematics binder.



You will now review a sample of student work. This sample will give you some insight on your own project.

- 
1. Turn to page 195 of the textbook and answer exercise 8 of Part C of “What Should I Be Able to Do?”

Compare your response with the suggested answer in the Appendix, Module Project, page 62.

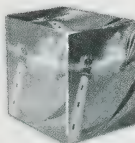
Next you will conduct the survey, analyse the results of the survey, and prepare your project. To prepare for this stage of your project, do the following.

- 
2. Turn to page 196 of the textbook and answer exercise 9 of Part C of “What Should I Be Able to Do?”
 3. What else should the person doing the sample survey check to help assess the viability of the hat-shop venture?

Compare your responses with the suggested answers in the Appendix, Module Project, page 62.

Module Project

Now that you have more insight into the module project, check over your work and make any revisions necessary. Next, turn to page 190 of the textbook and complete the activities in the last three bullets.



Now take out your Project Booklet and complete the Module 4 project, Feasibility of a Small Business.

Submit your completed Module 4 project to your teacher.

Module Summary

In this module, you identified the need for sampling and discovered what makes a sample biased. You identified reliability and validity as measures of how representative a sample is of the population. You identified biased sampling methods and analysed several reliable sampling techniques. You also identified and assessed the key components of a well-designed survey.

Designing and carrying out a reliable survey is a skill that is important in planning a business venture. It may mean the difference between a successful business and one that struggles to survive.

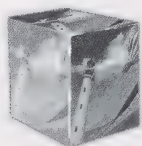


From the results of your survey, do you think your business plans would be a success?

Module Assignment

To demonstrate what you have learned in this module, complete the module assignment in the Assignment Booklet.

**Submit your completed Module 4 Assignment Booklet
to your teacher.**





Applied Mathematics 10

APPENDIX

GLOSSARY

Bias: an influence that prevents a sample from being truly representative of the population from which it is selected

Census: the process of collecting information from all the members of a population; an official count of the people of a country

Cluster sampling: a sampling method in which the population is divided into subsections, and then every member of a randomly chosen subsection is selected for the sample

Convenience sampling: a biased sampling method in which the sample is chosen at the convenience of the person doing the sampling

Inference: in statistics, a conclusion made about a population based on the results of a sample

Non-probability sampling: a sampling method that does not use random selection of the individuals in the sample

Population: all of the people, animals, or things about which the information is being collected; all the people who could have been consulted in the survey

Sample: the part of the population chosen to represent the total population

Sampling: the process used to choose part of the population to represent the entire population

Self-selected sampling: a sampling method in which individuals of a population select themselves to participate as members of the sample

Simple random sampling: a sampling method in which every member of the population has the same chance of being selected for the sample

Stratified random sampling: a sampling method in which the population is divided into groups, and then the sample is randomly selected from the groups

Survey: the process by which information is collected for a sample

Systematic sampling: a sampling method in which every n th member of the population is selected for the sample

SUGGESTED ANSWERS

Activity 1: Why Sample?

1. A sample was used because the population of Metro Toronto is too large to question all residents.
2. The definitions are as follows:
 - a. In a particular survey, the **sample** is comprised of the actual people who are consulted.
 - b. In a particular survey, the **population** is comprised of all the people who could have been consulted.
 - c. **Sampling** is a method used to gain information about a very large group by consulting a small, representative portion of the large group.

3. Textbook exercises 1 to 5 of “Investigation 1: Being One and Only,” pp. 166 and 167

1. As indicated in exercise 1 on page 166, the population could be the population of Canada or any other country, or the population of a province, city, or school. It could also be the population of a town or rural neighbourhood. It would be difficult to consider the entire world population since the number of children per family varies widely from culture to culture.
2. You can ask some of the population. For example, you could ask all the students in your class or a specified number of students from each class.

If you are not in a classroom situation, you could survey every fourth person you meet on the street in your town or survey several of your relatives.

3. The percentages will vary. You may theorize that the percentage from a small sample does not give a true indication of how many students in your class (or people you know in your city, town, or rural neighbourhood) are an only child. Generally, a sample of this size is too small to give accurate information about the entire population.
4. The percentages will vary. Your sample result may or may not reflect the actual number. It is likely that the results of the small sample will not be accurate.
5. The entire class would be a better predictor for the true number of “only child” persons in the school (also every fourth person you meet on the street would be a good predictor for the number of “only child” persons in your town). Generally, the larger the sample, the closer the results to actual numbers.

4. Textbook exercises 1 to 4 of “Investigation 2: Home, but not Alone,” p. 167

1. Percentages will vary. If your sample is large enough, you will find that the results of your sample compare quite well to the average number of children in the population of the class (or city, town, or rural neighbourhood).
2. Answers will vary. Your average could be 1, 2, 3, 4, 5, or higher. (**Note:** In 1998, the average Canadian family had 3.1 children.)
3. Answers will vary. Use an actual count to determine the average. Again, your answer could be 1, 2, 3, 4, 5, or higher.
4. Answers will vary. The results may be the same or the average may be “off” by ± 1 . It is unlikely an average would be “off” by more than ± 1 if the sample was adequate in size.

Activity 1 (continued)

5. Textbook exercises 1, 2, 3, 5, and 6 of “Exercises: Checking Your Skills,” pp. 168 and 169

1. Answers will vary. Random samples from the given groups may be taken.
 - a. the people living in a given city; riders on public transit
 - b. adult Canadians; high-school students
 - c. all Canadians; samples from each province
 - d. adult Canadians; high-school students
 - e. all NHL hockey fans; all Canadians; all Americans
2. Answers will vary.
 - a. all students of driving age in the given school; random samples of students of driving age in the school, teachers, and support staff
 - b. all students and staff in a given school; sampling of cafeteria patrons
 - c. all students in a given school; families of students in the given school
3. Answers will vary.
 - a. When deciding which movie to go see, you ask the opinion of some family members.
 - b. When deciding what band to get for a school dance, you ask the first 50 students you meet in the hallway.
 - c. The owner wants to know whether a certain product will sell and asks the opinion of a number of company employees.
 - d. You give a small sample of blood, urine, and so on for testing.
5. Answers will vary.

Data given as evidence for the article on page 186 of the textbook is “91% of more than 3500 residents contacted want to see expansion of rapid transit.” You should be able to cite similar evidence from the newspaper article about a survey that you found. Usually the information printed is believable. Reported surveys are usually done by firms knowledgeable in taking surveys.

6. You may or may not agree that 500 to 1000 respondents are adequate. Usually, a poll of 500 to 1000 randomly selected respondents is considered adequate since people often have similar opinions.

6. Textbook exercise 7 of “Exercises: Extending Your Thinking,” p. 170

7. Answers will vary.

- a. Unless you are sampling for a small town only, there are too many drivers to consider the entire population.
- b. It would be wasteful and costly to test all light bulbs in a particular production batch. Lights are usually not used continuously. Also, other factors affect the lifetime of a bulb (electrical surges, type of fixtures, and so on).
- c. Again, it would be wasteful and costly to measure the quantity of milk in every milk carton.

7. Textbook exercises 1 and 2 of “Discussing the Ideas,” p. 168

1. Answers will vary. Some problems and limitations could be as follows:

- A population may be too large to be surveyed entirely.
- A population may involve a widespread area; it is costly to survey all.
- Gathered data must be sorted; this is costly and time-consuming.

2. A complete census costs millions of dollars and is done every five years in Canada. The federal government hires census takers throughout the country to do a door-to-door survey. A count of the number of occupants in each household is done. Packages of information are left with most households and picked up after completion; other households are interviewed in person.

8. Textbook exercise “Communicating the Ideas,” p. 170

A population consists of all the people who could have been surveyed while a sample consists of the people who actually were surveyed.

Pros of taking a sample

- can be readily accomplished
- can be done relatively inexpensively

Cons of taking a sample

- may not be representative of the entire population

Pros of taking a census

- includes everyone or everything in the sample
- very accurate and representative of the entire population (if done well)

Cons of taking a census

- costly
- time-consuming

Activity 2: Reliability, Validity, and Bias of a Sample

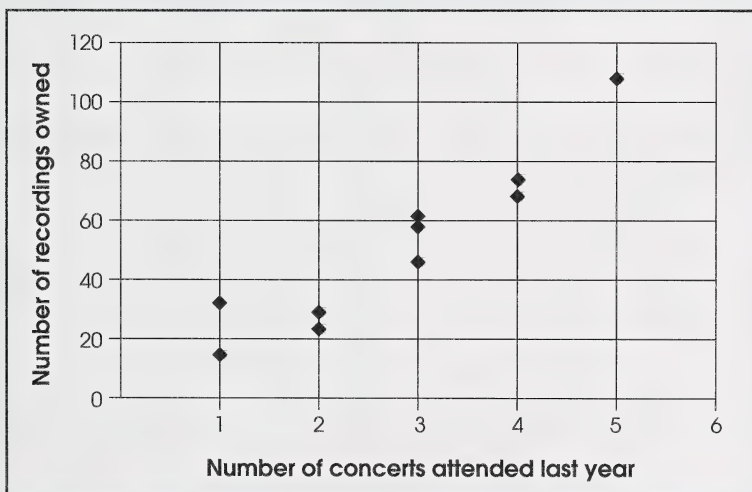
1.
 - a. A **sample statistic** is a numerical value that describes a characteristic of a sample. Some sample statistics that you are somewhat familiar with are mean, median, and mode (these terms were discussed in the junior high mathematics courses).
 - b. **Reliability** is the measure of whether a sample statistic, such as mean or median, can be duplicated from one survey to the next.
 - c. **Bias** is an emphasis on characteristics that are not representative of the population.
2.
 - a. You probably will find that most of your friends will like the CD, movie, or book.
 - b. Based on your friends' responses, you would likely say that most students in your school or those in your town should like the CD, movie, or book.
 - c. You will most likely find that not as many of your relatives will like the CD, movie, or book.
 - d. Yes, age may have a bearing on whether a person liked the CD, movie, or book.
 - e. The predictions about a general population based on the responses of your family members or relatives should be more accurate than when based on your friends' responses. You can say that your relatives or some of the people in your town are a more representative sample of the general population than your friends in regards to liking your CDs, movies, or books.
 - f. Using your friends as a sample to determine whether the general population would like a CD, movie, or book that you like would be a biased sample. This is because your friends would be more likely to have likes and dislikes that are similar to yours.
3. **Validity** is an indicator of how well a test measures what it is supposed to measure. **Note:** A sample statistic is valid if it closely approximates the same quantity for the population.
4. **Textbook exercises 1 to 6 of "Investigation 2: Validity," p. 172**
 1. Yes, you should expect a relationship between these two items since someone who is interested in music enough to attend concerts would most likely want to purchase CDs as well.

You could also argue that there is no relationship between the two. Concerts are very expensive; CDs or tapes are more affordable. Concert tours may not be accessible in your area and/or the musicians whose music you like may not do tours.

2. to 3. Answers will vary. If you are outside a classroom, interview friends or relatives.

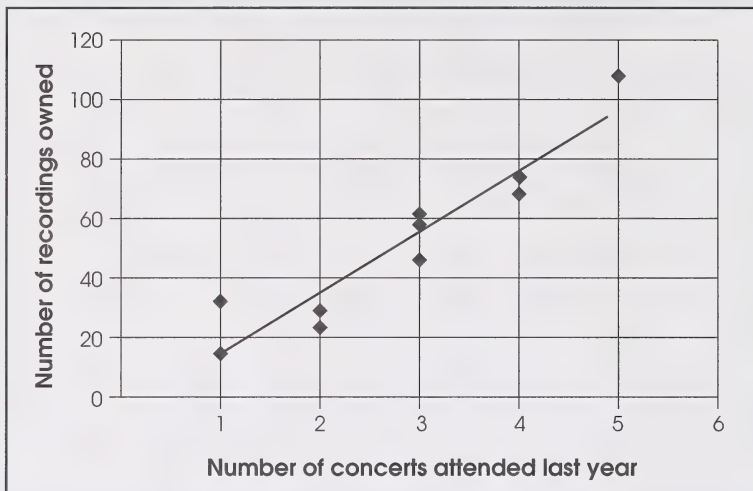
Your completed spreadsheet (or table) and scatterplot should look similar to the following (the data will likely differ).

	A	B	C
		Number of concerts attended last year (x)	Number of recordings owned (y)
1	Student		
2	1	4	74
3	2	1	31
4	3	3	60
5	4	1	14
6	5	2	22
7	6	5	109
8	7	3	45
9	8	3	57
10	9	4	68
11	10	2	27



Activity 2 (continued)

5. Yes, a line of best fit would be reasonable for this scatterplot. In this example, yes, the number of recordings owned can be predicted from the number of concerts attended. **Note:** Using Excel, you can easily add the line of best fit to a scatterplot. Simply select **Add trendline** from the Chart menu. Then select **linear**. The line of best fit for the data in exercises 2 to 4 looks like this:



You studied the line of best fit in Mathematics 9. This concept will be dealt with in greater depths in Module 6 of this course.

6. In this scatterplot example there is a strong agreement between the number of concerts attended and the number of recordings owned. Therefore, it would be quite valid to use the number of concerts attended and the graph to predict the number of recordings owned by students who were not part of the sample.

This may not be the case for your particular results. If you had scatterplot data that were widely separated and through which a line of best fit could not easily be drawn, then it may not be valid to use the graph to predict the number of recordings owned by students not sampled.

5. A phone-in survey may not give a representative sample of the population. In this example, only those really interested in racing may have responded. Also, there is no data as to the time frame of the survey. Therefore, the survey may not be valid.
6. The example on page 173 suggests that the survey result may not be valid due to a small sample size. The sample size is not stated with the survey result and if only five or ten people phoned in, this number would not be representative of the population of Calgary.

7. Textbook questions 1 to 7 of “Exercises: Checking Your Skills,” p. 174

1.
 - a. The intent of the survey was to gather student opinions on which is the best hockey team in the world.
 - b. A poll of people from all parts of the world or, at least, from all countries that have hockey teams, would have to be done.
 - c. The result of the survey is probably not valid. Polling students in only one country that has hockey teams will likely result in a biased response.
2. The survey results would not be valid if the population is considered to be all teenagers in the world. However, if the population is the magazine’s readers, then the survey likely is valid. The survey results could be reliable for a population of the magazine’s readers, but would not likely be reliable for all teenagers in the world.
3. The survey results are not likely to be valid since the sample is not representative of the population. It is likely that those who were motivated the most by the referendum would have voted in spite of the storm. The results could be reliable if another storm hits when another referendum is held. However, most likely, the survey results cannot be accurately duplicated and, therefore, are unreliable.
4. The advertisement wants the public to think that 75% of all dentists endorse the product. However, the sample size may have been very small or there may have been other circumstances influencing the endorsement, such as a payment for supporting the product.
5. The size and type of school could have implications on the validity of the sample. For example, if the school is only grades 10 to 12 and not very large, then the survey result may be valid. If the school includes grades 7 to 12 or if it is quite large then the survey results may not be valid. The survey results are probably reliable if only grade 12 classes are used as the sample again.
6. High marks in languages may not necessarily indicate high marks in mathematics and vice versa. The second language requirement may be for reasons other than marks. However, a passing grade in either subject would be expected of all applicants.
7. Height and weight may not necessarily determine the ability to do a good job as a firefighter. If strength is a requirement for a good firefighter, then height and weight could be fairly valid and reliable as indicators.

8. Textbook exercise 9 of “Exercises: Extending Your Thinking,” p. 175

9. Answers will vary. It may not be possible to obtain an unbiased sample. However, a sample that includes relatively equal numbers of those representing both sides of the issue may give an unbiased and relatively reliable sample. Sampling difficulties could be resolved by drawing from a wide variety of ages, occupations, and lifestyles (rural, urban, suburban, acreage) and by maintaining a balance of males and females.

Activity 2 (continued)

9. Textbook exercise “Communicating the Ideas,” p. 175

Answers will vary. The following is a sample response.

A valid sample is reliable because the definition of validity and reliability complement each other. A valid sample is one that measures what it is supposed to measure or has a survey result that is approximately the same as the survey result would be if the entire population was surveyed. A reliable sample result is one that can be duplicated by another survey using a new sample from the same population. If a survey result approximates the results of the entire population then it should be able to be duplicated. This makes it reliable.

Activity 3: Biased Sampling Techniques

1. The survey in the given example is biased because the fans in only one geographical region were sampled. This sample is not representative of the entire country.
 2. Two biased sampling methods are convenience sampling and self-selected sampling.
 - In convenience sampling, the sample is chosen at the convenience of the survey taker. For example, you may talk to every fifth person coming into a particular store.
 - In self-selected sampling, individuals of a population select themselves to participate. These individuals often feel strongly for or against a certain issue. For example, if the question concerns a town curfew for teens, it is likely that a large number of teens would choose to participate.
 3. The major characteristic that identifies a convenience sample is that the people involved in the sample have something in common, for example, they could be people entering a mall at a particular time.
 4. The major characteristic that identifies a self-selected sample is that those involved volunteer to be part of the sample; for example, you may choose to complete a satisfaction survey at a restaurant.
 5. A person offering perfume samples is non-probability sampling because it is convenience sampling and self-selected sample. It is convenience sampling because it takes place in only one area of a particular store, at times convenient to the person doing the “survey.” It is a self-selected sample because an individual can choose to participate or not.
- ### 6. Textbook exercise 1 of “Discussing the Ideas,” p. 178
1. A sample from “approachable” people is not representative of the population because these people have something—views, ideals, professions, locale—in common, while the general population probably does not have this common element. People you find “approachable” likely share many of the same views that you do.

7. Textbook exercises 1 to 6 of “Exercises: Checking Your Skills,” pp. 178 and 179

1. Those responding would be a self-selected sample. The chances of reproducing the results with the general population would be low; therefore, the reliability would be low. For example, in Alberta, there is a north–south rivalry—in sports, politics, and other areas. If you sampled people from Calgary about the Edmonton Oilers, responses would very likely be negative. People tend to defend and support their local area or group.
2. The readers who respond would be a self-selected sample and not representative of the population as a whole. Hence, the reliability would be low. The result could be reliable if the population is considered as being only the readers of the magazine.
3. The sampling of the recipes is not random. Some of the recipes could be over-sampled; others could be omitted entirely, perhaps depending on where the voters start sampling. The reliability would be low. Overpowering flavours in one recipe may also alter the ability to reliably test other samples. There are also varying tastes—some people prefer mild seasoning; others very hot.
4. Only those who are very satisfied or very dissatisfied may respond to the survey. The sample may not be valid or reliable for the owners of a particular model. People’s expectations and standards vary. Questions posed would have to be very definitive.
5. Only those who like movies in general will phone in. Therefore, the method is biased for the population as a whole. This may not be a problem, because to the TV station, the population is those who are interested in watching movies. Of those who like movies, perhaps only those with strong opinions either way about a particular movie may phone in, so there may be some bias. It is also possible that a charge could be involved for the 1-900 call. If this is the case, it would further bias results. The sample may not be valid or reliable for the entire movie-watching population.
6. The time of day of the assembly may have an effect on an item’s quality; hence, the sample may not be valid or reliable.

8. Textbook exercise 7 of “Exercises: Extending Your Thinking,” p. 179

7. Fans may tend to vote for local players thus putting some bias towards selections from other centres. Also, fans may not know as much about players in distant centres. Fans are also likely voting for their favourite players rather than the best players. The reliability and validity of the method may be somewhat suspect. Not all fans will vote, thereby making this a self-selected sample. No data is given. You may wish to know the following:
 - Does each centre get the same number of cards?
 - Is the same number of cards counted from each centre?

Activity 3 (continued)

9. Textbook exercise “Communicating the Ideas,” p. 179

Your outline may look similar to the following. Your outline may include other ideas.

Problems Associated with Convenience or Self-Selected Samples

A. Convenience Sample

1. The sample tends to be biased towards a particular group.
2. The sample is biased towards a certain place and time.

B. Self-Selected Sample

1. Only interested people tend to respond.
2. Generally, only people who feel strongly about the issue respond.

Activity 4: Unbiased Sampling Techniques

1. You would turn to only white pages of a telephone directory. Without looking, put a pencil on a number. Write down the last two digits of this number. Repeat this step until you have as many random numbers you want.
2. Textbook exercises 1 and 2 of “Discussing the Ideas,” p. 183
 1. Assign every member a number and use a random number generator to choose the sample.
 2. You should always ignore the first three digits when using the telephone directory to generate random numbers because the first three digits are the same for given areas. Thus, the first three digits are not random.
3. The following are sampling methods that do not use simple random numbers:
 - A simple random sample is used when the population is uniform and each member of the population has an equal chance of being selected.
 - A systematic sample is one in which the selections are based on regular intervals in time or in number of items manufactured.
 - A cluster sample is one in which an entire group is selected from a number of groups, assuming the individuals in each group were randomly selected and are representative of the entire population.
 - The stratified random sample is used when you have a population that contains subgroups and you want an equal representation from each subgroup.

4. Textbook exercises 3 and 4 of “Discussing the Ideas,” p. 183

3. The small sample will probably not be valid because the margin of error increases when the sample size decreases.
4. In a cluster sample, you would divide the community into regions, randomly select a region, and survey all the people in the selected region as your sample.

In a stratified sample, you would divide the community into regions and then randomly select a number of people from each region for your survey.

5. Textbook exercises 1, 2, 3, and 7 of “Exercises: Checking Your Skills,” pp. 184 and 185

1. No, this sample is not random for the general population because the sample comes from those who have already chosen to watch this particular program. This is a self-selected sample.
2. She used a systematic sampling method.
3.
 - a. You could select a simple random sample from a school population by assigning a number to each student, and then you could use one of the random number generator methods described on pages 180 and 181 of the textbook.
 - b. You could walk down each row in the parking lot and select every fourth car.
 - c. You could divide the city into regions, randomly select a region, and survey all the people living within the selected region.
 - d. You could randomly select a certain number of strawberries in each row of the strawberry field.
7. Since the production is most likely an assembly-line process, the sampling can be done through a systematic sampling method. You would select every n th widget for checking.

6. Textbook exercise 8 of “Exercises: Extending Your Thinking,” p. 185

8. You should advise them to use a stratified random sample in which they randomly select a number of students from each grade level. This method is chosen because it guarantees that the sample will include representation from each grade.

7. Textbook exercise “Communicating the Ideas,” p. 185

Effective and reliable sampling methods use a random method of selecting the sample. Although some of the methods use predetermined ways of selecting from particular groups, the individual members from the groups are randomly selected, or the sample group itself is selected randomly.

The basic flaw behind unreliable sampling methods is that the sample is not chosen randomly.

Activity 5: Survey Design

1. Textbook exercises 1 and 2 of “Discussing the Ideas, p. 188

1. The people left out of the survey are teachers, administrative staff, and caretakers. Their opinions should matter since they, too, are in the school.
2. A question as to the type of music desired could be posed. Such a question, however, would likely enlist a wide variety of music tastes that cannot all be accommodated. One would have to conclude that the rest of the student population will be satisfied with the music choice of the majority. A question concerning the volume of the music could also be asked. Perhaps, too, the population may wish to opt for no music.

2. a. Textbook exercise 1 or 2 of “Exercises: Checking Your Skills,” p. 189

Answers will vary. A sample response is given for exercise 1 and exercise 2.

1. A sample survey is done for Issue 1. Your survey for Issue 2 or Issue 3 would be similar.

Issue 1: Should a franchise be allowed to run the school cafeteria?

- a. Ask the question, “Are you in favour of having a franchise run the school cafeteria?”
- b. An unbiased sample can be selected by using a stratified random sample. Use a random number method to select a number of students from each grade level or from each division of each grade level. Around 5 students from each grade or division level can be selected. A representative of the teachers and support staff could also be randomly selected.
- c. The following steps could be used to conduct the survey.

Step 1: Select the entire school as the population.

Step 2: Be prepared to ask the chosen question and provide instructions to answer YES or NO.

Step 3: Select the sample. Make a list of those chosen for the sample.

Step 4: Approach those chosen for the sample, ask the question, and record each response as YES or NO. Check off each name to indicate that the person has been interviewed.

Step 5: Determine the number of YES responses and the number of NO responses and calculate the percent of yeses and noes for each response.

Step 6: Make a concluding statement about the responses to the question.

2. The following is a sample survey for Issue 1. Your survey for Issue 2 or Issue 3 would be similar.

Issue 1: Should people have to pay user fees for health care?

- a. The question could be, “Are you in favour of user fees for health care?”
- b. Randomly select names and addresses from the telephone books of the province.
- c. The following steps could be used to conduct the survey.

Step 1: Select the entire province as the population.

Step 2: Type up the question with instructions to circle YES or NO.

Step 3: Select the sample using a stratified random sample. Randomly select a proportionate number of names from each phone book.

Step 4: Mail the question to all those in the sample. (Including a stamped, return envelope would increase the chances of a response.)

Step 5: Record the responses and calculate the percent for the YES responses and the NO responses.

Step 6: Make a concluding statement about the responses to the question.

Note: The question could also be asked by phone. The response rate may be higher this way.

b. Textbook exercise 3 of “Exercises: Extending Your Thinking,” p. 189

3. The survey question could be something like the following:

Of the following six movies, pick the one you think will be selected for the Oscar for Best Picture.

Your sampling strategy will depend on the population that you want to sample. You could just sample students in your school or the people in your community. The broader the population the more likely your survey will be valid and reliable. However, costs for the survey could dictate how large a population one selects.

A concern might be whether all those in the sample are familiar with the movies. Timing of the survey would also be an issue; you might use the official list of movies (generally, there are only five movies in the category) or make up a list of your own. If you use the official list, you have to wait until the nominees are known. Also, the age of your population could bias the results.

Activity 5 (continued)

3.
 - a. The report entitled “Karma & Dogma” gives the least information about the survey design.
 - b. The survey that is reported in the article “Hold That Door—Survey Finds Older People Are More Polite” is the most informal.
4. The statement is a disclaimer about reliability. It means that, if the survey is repeated, the survey results will be duplicated 19 times out of 20, with a error margin of $\pm 1.6\%$.
5. The survey uses closed-ended questions.
6. **Textbook exercise “Communicating the Ideas,” p. 189**

The following is a sample of what you may write in your journal.

The identification of the population is important in a well-designed survey because you want the population surveyed to fit the purpose of the survey. If you are surveying what music to play in a school, then the population is the people in the school. There is little need to survey people outside the school. If you are surveying whether to increase the price of food in the school cafeteria by 20%, then it may be important to survey parents and other cafeteria patrons as well as students.

A clear and precise wording of the question is important in survey design so that those in the sample can understand exactly what is asked and what a particular response means.

A reliable sampling method is important to good survey design so that the survey fits the population that has been chosen for the particular survey. It is also important to have an unbiased method of selecting individuals for the sample.

A detailed plan of where and how the question will be posed is important to good survey design so that the way the question is asked is consistent for all those surveyed.

A calculation of the statistic (mean, median, mode, percentages, and so on) is important to the survey design so that others can see how the value was obtained. It should be possible to duplicate the results of a good survey.

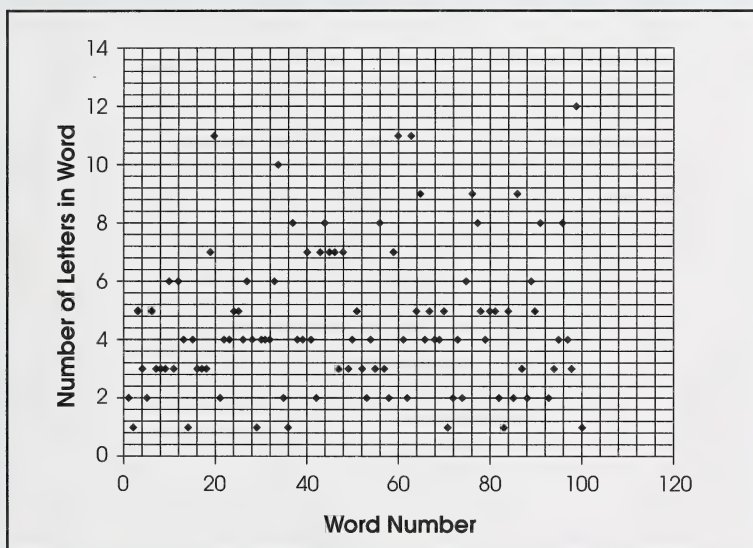
A conclusion with an inference about the population is important to good survey design since it answers the question for the population about which the survey is designed.

Follow-up Activities

1. Textbook exercise 1 of Part A of “What Should I Be Able To Do?” p. 193

1.
 - a. The population is all the words in the book.

- b. A simple random sample can be used. It would be best to pick out words with your eyes closed, since seeing a word may influence it being picked. You could also randomly select a number of pages in the book, then select every tenth word on the page.
- c. Answers will vary. Your textbook, the *Addison-Wesley Applied Mathematics 10 Sourcebook* is used in this example. You should have collected data for about 100 words.
- d. Your graph may look similar to the following if you did a scatterplot. The number of letters in a word have been plotted with the corresponding word number from 1 to 100. The graph shows how many words there are with a particular number of letters. You could also have done a bar graph.



e.
$$\text{Average} = \frac{\text{total number of letters}}{\text{number of words}}$$

$$= \frac{455}{100}$$

$$= 4.55$$

$$\doteq 5$$

A word cannot have a fraction of a letter, so you must round up to the nearest whole number.

The average number of letters in the words of the *Addison-Wesley Applied Mathematics 10 Sourcebook* is 5.

Note: If you use a spreadsheet to display your data, finding the average number of letters is simple. Follow these steps:

Step 1: Enter your data for the number of letters in each word in cells A1 to A100. Click on cell A101.

Follow-up Activities (continued)

Step 2: Choose **fx** from the toolbar. A Paste Function screen will appear.

Step 3: Select **Statistical** from under the Function category. Select **AVERAGE** from under the Function name. Click **OK**.

Step 4: An Average screen appears. The formula **= AVERAGE (A1: A100)** appears in the entry bar. Click **OK**. The average of the numbers from cell A1 to cell A100 will appear in cell A101.

2. Textbook exercises 2, 3, 4, and 6 of Part B of “What Should I Be Able To Do?” p. 194

2. Answers may vary. Sample answers are given.

- a. all students and staff in the school
- b. all students who could enter mathematics competitions, as well as their parents and teachers
- c. all residents of driving age in the particular country
- d. all taxpayers who would be supporting the transportation system

3. Answers may vary. Sample answers are given.

- a. Both gun owners and non-owners could bias a survey on gun control.
- b. Both dog owners and non-owners could bias a survey on owning pit bull terriers.
- c. Both supporters and non-supporters could bias a survey on gay rights.

4. Answers will vary. Sample answers are given.

- a. An example of a biased survey question could be the following:

Do you agree that reckless mountain climbers should pay the expenses of the rescuers who come to their assistance?

- b. A revised question may read as follows:

Do you agree that mountain climbers should pay the expenses of the rescuers who come to their assistance?

6. The following are different ways you could choose 6 students at random:

- Place all the student names in a hat, and draw 6 names, one at a time.
- Represent each student in the class with a number, and use your graphing calculator to generate 6 random numbers.

- Represent each student in the class with a number, and use your computer spreadsheet to randomly generate 6 numbers.
- List student names alphabetically and choose every n th student, to make a total of 6.

There are many other acceptable ways of choosing names at random.

Extra Help

1.
 - a. self-selected sampling
 - b. convenience sampling
 - c. convenience sampling
2. The responses from a phone-in talk show is not a reliable survey method because the sample is self-selected.
3. Answers will vary. Example situations are given.
 - **Simple random sample:** Assign a number to each member of the population and use a random number generating method to select the required number of members for the sample. This method is used when the population is small, for example, selecting a number of students from a class.
 - **Systematic sample:** Select an item or member of a population at regular intervals until an adequate sample is obtained. The systematic sample is used in industry for quality control.
 - **Cluster sample:** Subdivide the population into subgroups and select a subgroup at random. All members of the subgroup are part of the sample. A cluster sample is used when sampling wildlife that naturally cluster together in groups, and the groups are similar.
 - **Stratified random sample:** Subdivide the population in subgroups based on some characteristic. Select members at random from each subgroup. The stratified random sample is used when the population is large, and the groups are diverse. It allows you to select a predetermined number of members from each subgroup according to some characteristic, such as size or colour.

Enrichment

1. Answers will vary. Your discussion should indicate how each survey contained the six key components of a well-designed survey. You may have discovered that surveys produced by companies in the business of surveys produced surveys that consistently were good.
2. **Textbook exercise 5 of Part B of “What Should I Be Able To Do?” p. 194**
 5. a. Teachers who are quite satisfied and those who are quite dissatisfied may be more likely to respond to the survey.
 - b. The survey may not be valid since those that respond may not be a representative sample of all grade 10 to 12 mathematics teachers.
 - c. The sampling method used is the self-selected sampling method.

Module Project: Feasibility of a Small Business

Completing the Project

1. Textbook exercise 8 of Part C of “What Should I Be Able to Do?” pp. 194 and 195

8. Answers will vary. A sample response is given. Exactly who would be surveyed, when, and how is not mentioned. Therefore, it is not possible to determine if the survey method is reliable.

The survey questions are quite clear and closed-ended. To make tabulation easier, it would be preferable to allow for only one response per question. People being interviewed may not know what “The Lid” is. Perhaps a short explanation could be given. It would be useful to know the age range of the person answering the survey. It might also be a good idea to ask “household” questions rather than “personal” questions.

The student did not complete the work in the first bullet and the work in the third bullet on page 190 of the textbook. The student completed satisfactorily the work in the second bullet on page 190 of the textbook.

2. Textbook exercise 9 of Part C of “What Should I Be Able to Do?” p. 196

9. There appear to be some errors in the calculations. In question 2, the percentages do not add up to 100% for the column. **Note:** In question 5 the percentages in each row do not add up to 100%; however, this is probably due to the fact that people shopped at more than one time period.

The summary results indicate that 200 people were surveyed and that the survey was done on a weekday and on the weekend. The summary also indicates that people of a wide range of ages were surveyed, but this must have been a guess, as the survey does not ask the person’s age range.

The conclusions about the viability of the venture appear reasonable. There is a reasonable market for caps and toques. The student stated that close to half (48%) of the number surveyed buy a hat every year, but in fact 79% stated they buy 1 or more hats per year. The statistics would have been easier to analyse if the questionnaire allowed for only one response per question.

3. Answers will vary. The surveyor would have to check if there is a reasonable markup and how many hats would have to be sold to pay for expenses. The number of staff and amount of wages are not mentioned.

CREDITS

Some clip art drawings are commercially owned.

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| 7 | (Collage) upper right: Image Club/StudioGear/EyeWire, Inc.
lower left: PhotoDisc, Inc. | 26 | PhotoDisc, Inc. |
| 9 | PhotoDisc, Inc. | 27 | bottom: PhotoDisc, Inc. |
| 12 | upper left: PhotoDisc, Inc. | 28 | bottom: Image Club/StudioGear/EyeWire, Inc. |
| 14 | PhotoDisc, Inc. | 29 | top: PhotoDisc, Inc.
bottom: Image Club/StudioGear/EyeWire, Inc. |
| 15 | PhotoDisc, Inc. | 30 | bottom right: EyeWire, Inc.
bottom left: Image Club/StudioGear/EyeWire, Inc. |
| 16 | PhotoDisc, Inc. | 31 | top: Image Club/StudioGear/EyeWire, Inc.
bottom: EyeWire, Inc. |
| 19 | middle: EyeWire, Inc.
bottom: Image Club/StudioGear/EyeWire, Inc. | 32 | Corel Corporation |
| 20 | Corel Corporation | 33 | Image Club/StudioGear/EyeWire, Inc. |
| 21 | top: PhotoDisc, Inc.
bottom: Image Club/StudioGear/EyeWire, Inc. | 35 | Image Club/StudioGear/EyeWire, Inc. |
| 22 | PhotoDisc, Inc. | 36 | Image Club/StudioGear/EyeWire, Inc. |
| 23 | top: Image Club/StudioGear/EyeWire, Inc. | 37 | Image Club/StudioGear/EyeWire, Inc. |
| 24 | Image Club/StudioGear/EyeWire, Inc. | 39 | Image Club/StudioGear/EyeWire, Inc. |
| 25 | top: Image Club/StudioGear/EyeWire, Inc.
bottom: Image Club/StudioGear/EyeWire, Inc. | 40 | PhotoDisc, Inc. |
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